Assessment of Port Concession Projects Quality Based on the Information and Analytical Risk Management System

Varvara Piterska[a], Valentina Samoilovska[a] and Viktor Adakhovskyi[a]

[a] *Odesa National Maritime University, 34, Mechnikov str., Odesa, 65026, Ukraine*

Abstract
The subject of research in the article is the methods, models and mechanisms for assessing the quality of projects. The purpose of the article is to develop a science-based method for assessing the quality of concession projects in seaports based on the use of a system of risk-based management of port activities. The following tasks are solved in the article: the conceptual apparatus of project management in the port, public-private partnership is considered, the problems that arise during the concession projects implementation in the seaport activities are analyzed, the goals of the stakeholders of the concession project are determined. The following results of the study were obtained: a classification model of risk management at the stages of the life cycle of a concession project was developed, a model was developed for determining the degree of influence of risks on the competitiveness of a port based on the information and analytical management mechanisms, a mechanism was developed for selecting the most significant risks that affect a change in the preferences of stakeholders during the implementation of a concession project in Port. Conclusions: the goal of the development of seaports is to provide competitive services for the handling of ships and cargo. The implementation of the concession project in the port is an effective form of reforming the port activity. The concession projects stakeholders in the seaport are government agencies, business structures and the population (including the port labor collective), which form a triple system of interaction, which we will call the "S-B-C" system. The article identifies the risks arising from the implementation of concession projects in the port. An information-analytical model of risk management is proposed, which allows choosing an investment development project, the use of which makes it possible to ensure the competitiveness of services provided by the port.

Keywords 1
Concession project, information system, port, risk management

1. Introduction

The strategic goal of the development of sea trade ports of Ukraine is to achieve soon such a level of development of port infrastructure based on the use of modern information technologies that would ensure the effective functioning of ports as elements of the international transport network.

The effective functioning of maritime transport is a necessary condition for the formation of the developed country as a maritime state with the efficient functioning of the transport complex and the economy as a whole [1].

The need to reform the maritime industry of Ukraine and its stable development actualizes the research of world experience in the implementation of the concession form of public-private

partnership in seaports and the use of modern mechanisms for project-oriented management of the organizations' development.

The implementation of investment development projects based on a concession will accelerate the social, economic state of the country and increase the standards of living of citizens.

2. Analysis of Literature Data and Resolving the Problem

In recent years, the issue of introducing the institution of public-private partnership has become one of the main priorities of government strategic development programs, an indicator of successful interaction between business and government structures, an alternative way to restore and modernize the national economy, and an effective industry for the use of modern information technologies in the port industry [2-5].

Public-private partnerships in seaports can be implemented in such forms as joint activities, leases, concessions [6, 7].

The most common form of public private partnership in the seaport industry is the implementation of concession projects [8].

The state authorizes the business partner to perform the functions specified in the concession contract for a specific time and gives him authority for this purpose necessary to ensure the effective functioning of the concession object while remaining the full owner of the property that constitutes the subject of the concession contract [9-11].

A fee for the use of state property on the terms stipulated in the agreement is paid by the concessionaire [12-14].

Many domestic and foreign scientists devoted their scientific works to the study of the issues of determining the essence of the concept of concession, the distribution of risks, the duration of the concession agreement, the amount of concession payments, the effectiveness of the concession in seaports [15-18].

The concession can become the main way for the strategic development of the port economy. As part of the implementation of concession projects, the state does not lose its ownership of fixed assets and does not bear the cost of maintaining economic infrastructure in ports [19, 20]. A private investor invests his funds as a concessionaire and receives stability in work for a long period - up to 50 years, improves, modernizes the fixed assets of cargo and passenger terminals [21].

A concession can be considered a form of public-private partnership that helps attract investment in infrastructure sectors and is a system of relations between the state and business that arises during the creation (reconstruction) of a state-owned object of great socio-economic importance [22, 23].

The main problem in the concessions' implementation is the lack of scientific researches of the use of risk management mechanisms in seaports.

3. The Purpose and Objectives of the Research

The purpose of the article is to develop a science-based method for assessing the quality of concession projects in seaports based on the use of a risk-based management system of port activities.

The objectives of the study include:
- Consideration of the conceptual model of project management in the port, public-private partnerships
- Analysis of problems arising from the concession projects' implementation in the activities of the seaport
- Determination of the stakeholders' goals of the concession project, development of a classification model for risk management at the stages of its life cycle
- Development of the impact degree definition model of risks on the competitiveness of the port based on information and analytical management mechanisms
- Selection of the most significant risks of the implementation of a concession project in the port that affect the change in the preferences of stakeholders.

4. Materials and Methods of the Research

The stakeholders of concession projects are the state, business, and the population, which causes triple interaction due to the multiplier effect to ensure a balance between the interests of the state, business, and the population (the workforce in the port, citizens) [24, 25].

The state, business and the population as the stakeholders of the concession project in the port form a triple system of interaction, which we will call the S-B-C model. This model combines the processes of port activities, various forms of state regulation, which are in interact with each other.

The state solves the problem of construction, modernization of important facilities related to port infrastructure, which contributes to an increase in the efficiency of state property management, weakening the budget burden, and increasing budget revenues [26, 27].

Business expands the scope of investment, receives additional income from related activities for carrying out cargo operations, servicing ships in the port, while the presence of long-term contractual relations with the state leads to a reduction in the risks associated with the implementation of investment projects, expansion of credit opportunities secured state guarantees [28, 29].

Shipowners and cargo owners get the opportunity to use high-quality services provided by the concessionaire under a concession agreement, at established rates for handling a vessel, cargo, while creating new jobs in the port [30, 31].

The S-B-C model has obvious advantages - the port is experiencing the need to increase the competitiveness of its services, the state is implementing incentive measures, business structures are adapting to the needs to improve the quality of port services and use modern information technologies.

This paradigm implies that the business, when implementing a concession project, improves port production technologies as part of the provision of port services, which affects the productivity of handling ships and cargoes, the competitiveness of the port in general and the state of the workforce in the port in particular in the context of flexible state regulation.

The complexity of implementing such a model is explained by the unequal goals of different stakeholders of the concession project. The strategic goal of the state is the improvement of the life quality of citizens in the respective territories.

The value of a comprehensive indicator of the life quality is calculated considering the analysis of a set of criteria grouped in the relevant areas:

$$Q_i = f(L_i, G_i, P_i, D_i, E_i), \tag{1}$$

where L_i is an indicator characterizing the level of quality of life of the population in the i-th territory of the state;

G_i is the indicator characterizing the level of security in the i-th territory of the state;

P_i is the indicator characterizing the level of infrastructure development (including port infrastructure) in the i-th territory of the state;

D_i is the indicator characterizing the level of income in the i-th territory of the state;

E_i is the indicator characterizing the state of ecology in the i-th territory of the state.

For businesses, the main indicators are profitability in carrying out their activities in the port.

The conceptual model for the distribution of goals of stakeholders of concession projects in the port within the framework of the S-B-C system is presented in Figure 1.

The advantages for the state of participating in the concession project in the j-th port considering the S-B-C model can be characterized by a complex indicator that takes into account the following areas of activity:

$$S_j = f(T_j, A_j, V_j, K_j), \tag{2}$$

where T_j is the indicator of the weakening of the budget burden due to the shifting of part of the costs to business during the implementation of the concession project in the j-th port;

A_j is the indicator of increasing the economic efficiency of state property management in the implementation of the concession project in the j-th port;

V_j is the indicator of shifting part of the risks to the business when using the information and analytical risk management system when implementing the concession project in the j-th port;

K_j is the indicator of increasing the level of budget revenues due to tax deductions and other payments during the implementation of the concession project in the j-th port
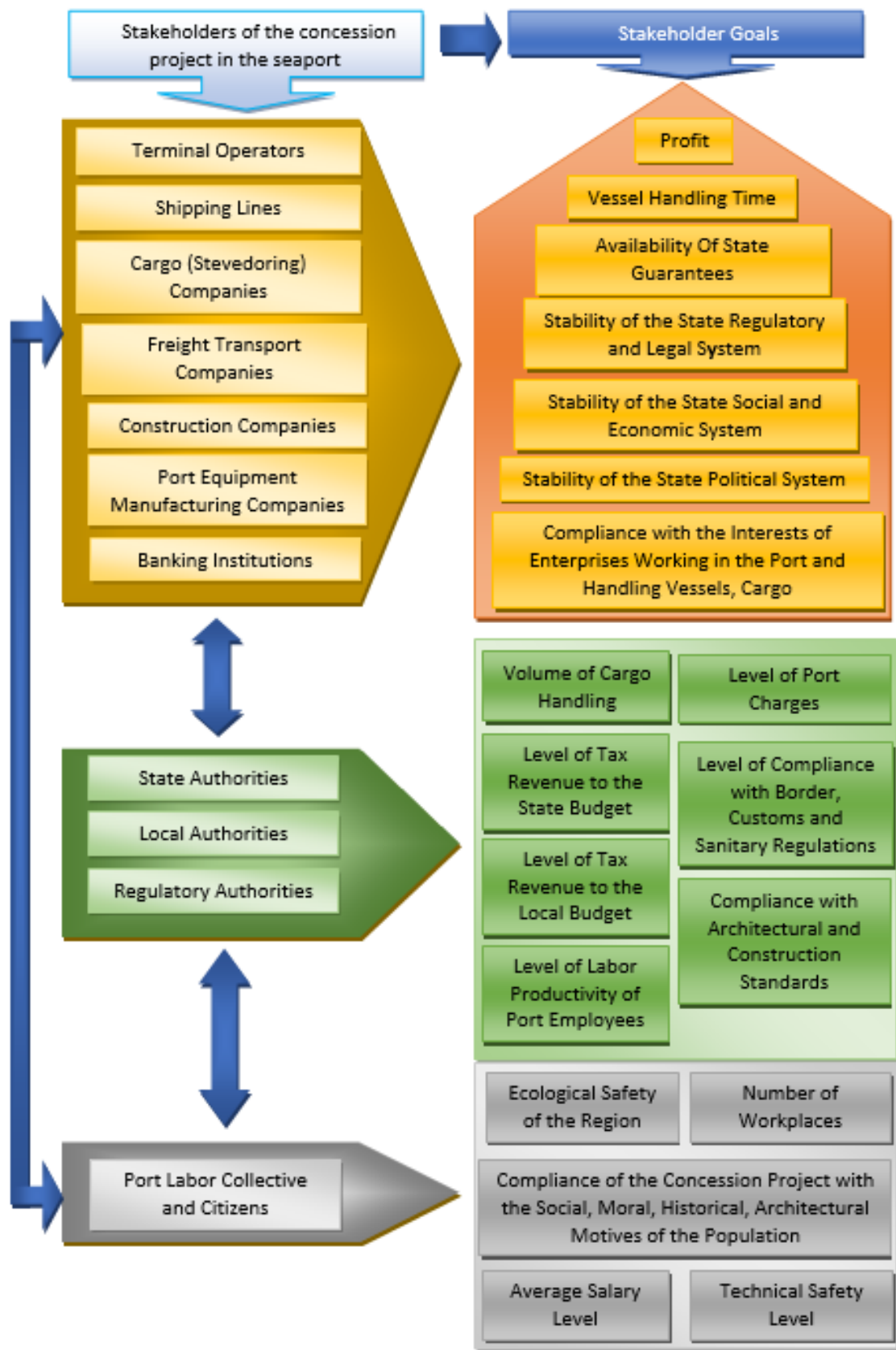
Figure 1: Conceptual model for the distribution of goals of stakeholders of a concession project in the port considering the S-B-C system

Improving the quality of activities of business structures during the concession project implementation in the j-th port considering the S-B-C model is described by the complex indicator:

$$B_j = f(W_j, Z_j, R_j, H_j, M_j), \tag{3}$$

where W_j is the indicator of tax incentives for business in the concession project implementation in the j-th port;

Z_j is the indicator of attracting public funding in the concession project implementation in the j-th port;

R_j is the the indicator of risk minimization in the concession project implementation in the j-th port;

H_j is the indicator of additional profit in the concession project implementation in the j-th port;

M_j is the indicator of the use of modern information technologies in the implementation of the concession project in the j-th port.

For the population, including the workforce of the j-th port, in which the concession project is being implemented within the S-B-C model, the benefits are assessed by calculating the complex indicator:

$$C_j = f(Y_j, X_j, N_j), \tag{4}$$

where Y_j is the indicator of reducing social tension due to the creation of new jobs during the implementation of the concession project in the j-th port;

X_j is the indicator of cost reduction of port services during the concession project implementation in the j-th port;

N_j is the indicator of the quality improvement of services provided through the use of modern information technologies in the j-th port during the implementation of the concession project.

The implementation of a concession project is associated with a large number of risks, both characteristic of all stages of its implementation and inherent in individual stages within the life cycle - concluding a concession agreement, designing an object of a concession agreement, building (modernizing) port infrastructure facilities, operating a seaport when providing services to cargo owners and ship owners.

Unlike other forms of public-private partnership, the risks of a concession project are redistributed among its participants - the state, the investor, insurance companies, and banking institutions.

The party most vulnerable to the manifestation of risks within the S-B-C model inherent in all stages of the life cycle of an investment development project in the port is the investor - a business structure that is exposed to risks arising from the modernization and operation of port infrastructure facilities.

The process of constant and systematic identification of risk sources, assessment of the significance of risk factors contributes to making decisions on the optimal management of the port in the context of the implementation of the concession project.

The structural model for calculating risks arising in the S-B-C system when using information technology includes the steps shown in Figure 2.

The task of managing the activity of a seaport taking into account risk factors considering the use of information technologies is reduced to determining the minimum expected risk for all possible risk parameters, taking into account their posterior probabilities (Bayes strategy).

The model for calculating the minimum losses of the port system during the implementation of the concession project considering the S-B-C model includes the availability of initial data, namely:

μ is the number of risk factors in the implementation of the concession project under the S-B-C model;

$\alpha_\mu \in [k; h]$ is risk factor deviation limits;

Ω is a set of port system states ($f \in \Omega$);

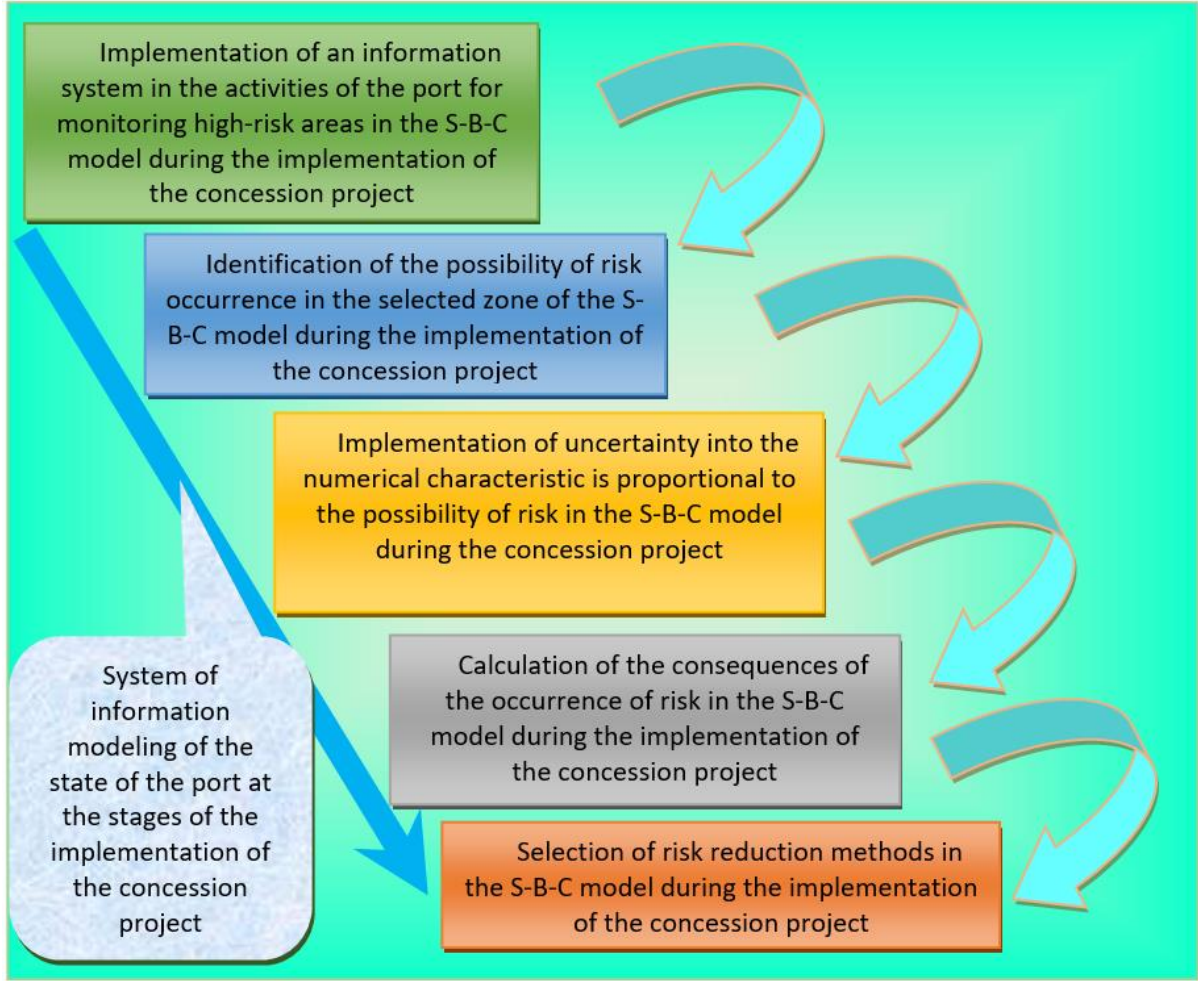V is a set of solutions ($v \in V$).

Figure 2: Structural model for calculating risks in the implementation of a concession project in a port within the framework of the S-B-C system

The range α_r is divided into n intervals (i = 1,…,n is the ordinal number of the interval) with the coordinates of division points determined. In each range, it is considered optimal to select a specific project G of the concession in the port, which provides an increase in the competitiveness of port services.

Next, the prior probabilities are determined:

$$P_i(1) = \frac{\alpha_\mu^i - \alpha_\mu^{i-1}}{h-k}, (i = 1, …, n).$$ (5)

After that, the risk matrix R_{ij} is built, associated with the decision G_j instead of G_i (Table 1):

$$R_{ij} = R_i(G_j) - R_j(G_i)$$ (6)

We determine the vector of the expected risk in the implementation of the concession project in the port:

$$W(m) = \|R_{ij}\|P(m),$$ (7)

where P(m) is the vector of a posteriori probabilities that $\alpha\mu$ belongs to the partition interval [k; h] at the beginning of period m.

Let us propose a classification model of risk factors α_μ arising from the implementation of a concession project in a port with the participation of stakeholders of the S-B-C system (Table 2).

Table 1

Risk matrix coefficients $\|R_{ij}\|$ in the seaport concession project

Interval	Number of selected G			
	1	2	…	m
1	0	R_{12}	…	R_{1m}
2	R_{21}	0	…	R_{2m}
…	…	…	0	…
n	R_{1n}	R_{n2}	…	0

Table 2

Classification model of risk factors α_{μ} in the seaport concession project

№	Risk factors	CP	PDP	PIP	PCP	PFP
1	Changes in the legal framework related to the implementation of concession projects	Medium	Significant	Significant	Medium	Medium
2	Changing priorities in the socioeconomic development of the state	Significant	Significant	Medium	Minor	Medium
3	Changing the political situation in the country	Medium	Significant	Medium	Medium	Minor
4	Corruption in public authorities	Significant	Significant	Significant	Significant	Significant
5	Reduction/termination of state funding for concession projects in the port	Medium	Significant	Significant	Medium	Significant
6	Inflation, currency fluctuations	Medium	Significant	Medium	Minor	Significant
7	Lack of qualified specialists and experience in interaction between the parties in the implementation of concession projects in the port	Significant	Medium	Significant	Medium	Medium
8	Martial law, strikes, natural disasters	Significant	Significant	Significant	Significant	Significant
9	Embargo, export/import restrictions	Minor	Medium	Significant	Medium	Significant
10	Increasing the level of taxes	Minor	Minor	Medium	Significant	Medium
11	Poor construction/modernization of port infrastructure	Minor	Medium	Significant	Medium	Significant
12	Exceeding the planned period of construction/modernization of port infrastructure facilities	Minor	Minor	Medium	Minor	Significant
13	Lack of software for the implementation of a modern information system for managing the port's activities	Medium	Medium	Significant	Minor	Medium
14	Presence of a complex procedure for approving the feasibility study of the concession project in the port	Significant	Significant	Medium	Medium	Medium
15	Late delivery of equipment, construction materials and other resources	Minor	Significant	Significant	Medium	Significant
16	Lack of electricity supply	Significant	Significant	Significant	Significant	Significant
17	Lack of a well-developed justification for the amount of payment for port services under the concession agreement	Medium	Minor	Minor	Minor	Medium
18	Unclear elaboration of issues of conflict resolution between the stakeholders of the concession project	Medium	Medium	Medium	Significant	Significant
19	The negative impact of the port activity on the ecology of the region	Medium	Significant	Significant	Medium	Significant
20	Increasing the cost of equipment, construction materials and other resources	Medium	Medium	Significant	Medium	Significant
21	Change in the cost of port services due to changes in the tariff policy of the state	Minor	Minor	Medium	Medium	Medium

⛱ – Significant impact; ☁ – Medium impact; ☀ – Minor impact

The minimum component w(m) indicates the decision, the adoption of which and the selection of the corresponding concession project G in the port at step m are associated with the least risk for project stakeholders in the framework of the S-B-C model.

To determine the risk from the implementation of concession projects in the port, it is proposed to distribute the risks depending on the stages of the project life cycle.

To determine the directions of the port's activities in handling cargo and ships based on a rational concentration of resources to prevent the occurrence of risk situations, we will introduce a rank system for evaluating criteria.

In this case, the following classification of measures to counteract (prevent) risk situations is used:

- Stop&Change – abandonment of the previously selected feasibility study of the port investment development project and transition to the consideration of the possibility of implementing a more efficient concession project in terms of minimizing risks in the port
- Continue&Insure – implementation of the selected concession project in the port and continuation of a certain stage of the life cycle of the concession project, transition to the next stage, risk insurance
- Continue&Finish – continuation of a certain stage of the concession project life cycle selected for implementation in the port with minor changes.

The structure of the life cycle of a concession project in the port has the following sequence of project phases: Concept Phase (CP), Project Development Phase (PDP), Project Implementation Phase (PIP), Project Control Phase (PCP), Project Finish Phase (PFP).

The distribution is carried out depending on the degree of damage to the concession project stakeholders in the port.

The severity of the consequences is defined as follows:

- Significant impact implies the possibility of losses in case of unfinished concession project (its certain stage), the port services will be uncompetitive (financing was carried out in full, there are significant losses of funds)
- Medium impact assumes that the costs of the port investment development project have not paid off in full (the costs of port activities are compensated by insurance payments)
- Minor impact comes from the possibility of insignificant losses, offset by income from the provision of port services.

We form a risk matrix for investment development projects of the port (Table 3).

Table 3
Concession project risk matrix

Qualitative characteristics of the frequency of the event	Frequency of the event	Significant impact	Medium impact	Minor impact
Frequent	>1	Stop&Change	Stop&Change	Continue&Insure
Probable	$1 - 10^{-1}$	Stop&Change	Stop&Change	Continue&Insure
Random	$10^{-1} - 10^{-2}$	Stop&Change	Continue&Insure	Continue&Finish
Unlikely	$10^{-2} - 10^{-4}$	Stop&Change	Continue&Insure	Continue&Finish
Implausible	$10^{-4} - 10^{-6}$	Continue&Insure	Continue&Finish	Continue&Finish
Unbelievable	$<10^{-6}$	Continue&Insure	Continue&Finish	Continue&Finish

The analysis of risk factors arising from the implementation of the concession project in the port, shown in Table 2, determines the cost estimate of each factor and the choice of priority factors based on the probability of these factors occurring within the S-B-C model of the port's activities.
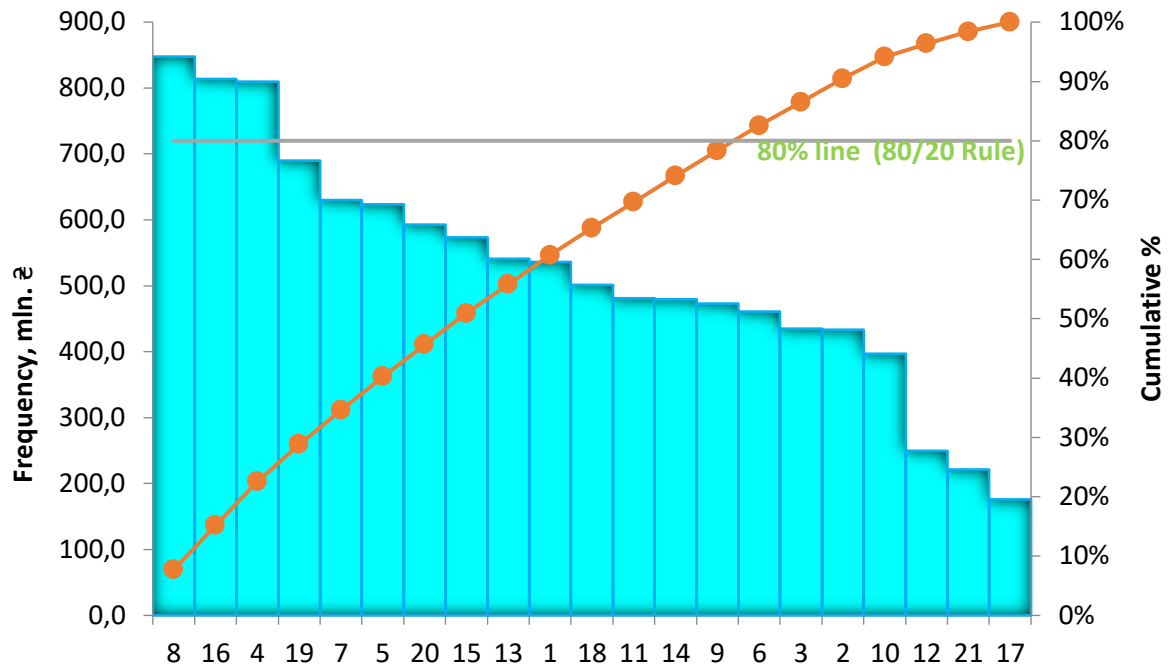
Figure 3: Assessment of the impact of risk in the implementation of the concession project in the port

A preliminary assessment shows that the risks associated with martial law, energy supply problems, corruption, negative impact on the region's environment, insufficient qualifications and inconsistency of the actions of the project team representing the interests of stakeholders, increase in cost and violation of the terms of delivery of equipment, building materials and other resources, lack of software for the implementation of a modern information system for managing the port, changes in legislation, deviations in the processing time of ships and cargo due to poor construction, modernization of port infrastructure facilities have the greatest influence on the choice of an effective concession project in the seaport.

5. Conclusions

The current state of development of seaports was analyzed and it was found that the ports require significant reform of the existing infrastructure. One of the types of modernization of ports is proposed to consider concession projects as one of the types of public-private partnerships.

As part of the study, the stakeholders of concession projects were identified, which include state bodies, business structures and the population (subjects participating in the port's activities - the labor collective and persons not directly related to the port, but indirectly influenced by the results of its activities). The specified stakeholders of the concession project form a single S-B-C system, which involves cooperation with the use of modern information and analytical interaction mechanisms.

Every stakeholder of the port investment development project has certain targets, the achievement of which is aimed at ensuring the quality of the port services provided.

The paper proposes a classification model of risk management, which made it possible to develop a mechanism for minimizing the negative impact of risks on the port's activities based on the use of information technologies.

The most significant risks were the risk of martial law, the risk of lack of electricity, environmental risk, the risk of insufficient qualification of personnel, the risk of lack of information and software, as well as the risk of increasing the time and cost of handling vessels and cargo.

The obtained results of the study make it possible to select a concession project that will increase the competitiveness of the port based on an information system to minimize the impact of risk factors on the quality of services provided by the port.

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